COTTAGERS SELF-HELP PROGRAM ENRICHMENT STATUS OF NINETEEN LAKES IN THE SOUTHEASTERN REGION OF ONTARIO 1975

Ministry of the Environment
Ontario

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by

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Ministry of the Environment

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ABSTRACT

This report presents the data collected from 19 lakes in the Southeastern Region of Ontario during the summer of 1975. The data was collected through the assistance of volunteers who took Secchi disc readings and water samples from lakes on which they were located. The results provide the Southeastern Region, Ministry of the Environment with a means of monitoring water quality in the lakes surveyed.

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Through the efforts of these volunteers the Ministry of the Environment has been able to assemble valuable water quality data which would not otherwise be available. This is a significant contribution to the maintenance of water quality in our recreational lakes.

INTRODUCTION

Over the past years, an increasing awareness for problems of water quality impairment in our recreational lakes has materialized. The Ontario Ministry of Environment and other government agencies involved in the control and management of shoreline development of cottages and resorts are concerned with the maintenance of good water quality. A recreational lake program was established in 1970 and is a continuing study to collect and assess data on lakes in the Province to ensure that future development and recreational use of these waters will be well managed to protect their quality.

During 1975, the Southeastern Region of the Ministry of the Environment and the Eastern Region of the Ministry of Natural Resources carried out water quality surveys on 48 lakes located in Frontenac, Lennox and Addington, Leeds and Lanark Counties. Another 50 lakes will be surveyed in 1976. This study will include some lakes in Hastings and Renfrew Counties, as well as additional lakes in Lennox & Addington and Frontenac Counties. The information collected by these surveys, and the physical characteristics of a lake and its drainage basin will be used to evaluate a lake's probable capacity for development to maintain a water quality suitable for existing uses of the lake. The results of the data collected in 1975 are still being analyzed. A joint report will be issued this fall which will indicate what lakes are sensitive to development.

With the many hundreds of lakes in our region, we do not have the resources to conduct such surveys on all lakes annually, nor are they necessary to monitor water quality in our recreational waters on a routine basis. In 1971, a relatively simple but effective "Self-Help Program" was introduced in which cottagers' associations and individual lake residents volunteer their time to measure the clarity of their lake and to collect water samples at weekly intervals. The volunteers are supplied with the necessary sampling equipment, bottles and instructions and are asked to ship the water samples to the nearest Ministry of the Environment Laboratory where they are analysed for their algae content as reflected by chlorophyll a levels. The succes of the program is exemplified by the fact that the number of lakes included in the province increased from 12 of the first year of its operation to approximately 100 in 1974.

This report presents the data collected from 19 lakes in the Southeastern Region of Ontario during the summer of 1975 (see table 1), incorporates the information into a graphical relationship, and comments on the findings in an attempt to define the degree of aquatic enrichment or trophic status of the lakes. Appendix A provides a brief explanation of water quality problems in recreational lakes. The Southeastern Region includes Hastings and Renfrew Counties and extends eastward to the Quebec border.

Table 1: Location of Lakes in the Southeastern Region which were sampled in 1975 as a part of the self-help program.

LAKE		LOCATION
1.	Baptiste	Herschel Twp., Hastings County
2.	Big Rideau	North Burgess and North Elmsley Twps., Lanark County and Bastard, South Burgess and South Elmsley Twps., Leeds County
3.	Bobs	Bedford Twp., Frontenac County
4.	Collins Bay	Kingston Twp., Frontenac County
5.	Lac Coulonge	Westmeath Twp., Renfrew County
6.	Crowe	Marmora Twp., Hastings County and Belmont Twp., Peterborough County
7.	Devil	Bedford Twp., Frontenac County
8.	Glanmire	Tudor Twp., Hastings County
9.	Grippen	Rear of Leeds Twp., Leeds County
10.	Hurds	Bagot Twp., Renfrew County
11.	Limerick	Limerick Twp., Hastings County
12.	Loughborough	Storrington Twp., Frontenac County
13.	Mazinaw	Abinger Twp., Lennox & Addington County, & Barrie Twp., Frontenac County
14.	Mink	Wilberforce Twp., Renfrew County
15.	Otter	Bastard and South Elmsley Twps., Leeds County
16.	Otty	North Burgess and North Elmsley Twps., Lanark County
17.	Salmon Trout	Monteagle Twp., Hastings County
18.	White	Olden Twp., Frontenac County
19.	White	Bagot and McNab Twps., Renfrew County and Darling Twp., Lanark County

METHODS

Water clarity which governs the depth of light penetration into a lake is one of the most important parameters used in defining water quality and can be measured using a Secchi disc. The disc is divided into black and white alternating quadrants and is lowered into the water on a graduated line until the quadrants cannot be distinguished. The depth is noted and the disc is raised slowly until the quadrants are just visible - again the depth is noted. The average of these two depths is termed the Secchi disc depth. As depicted in Figure 1, Secchi disc depths are substantially greater in lakes having low phytoplankton (microscopic free-floating algae) numbers than in lakes characterized by high algal densities and excessive vascular aquatic plant growths. Secchi disc readings were taken as often as possible during the summer in the deep-water zones of the lakes.

Chlorophyll a is a photosynthetic green pigment in algae and its concentrations can be used as a rough indication of the extent of biological activity in a lake at the time of sampling since it is regulated by all of the combined physical, chemical and biological factors which affect algal production. Chlorophyll a samples were taken on each visit to the lakes by lowering a narrow-mouthed bottle (32 ounce capacity) to the approximate location of the 1% incident light level, or through the zone of effective algal production. The extent of this zone was determined by doubling the value of the

Secchi disc depth. The speed of lowering and raising the bottle was regulated so that the bottle was just filled when it reached the surface; the object being to collect a composite water sample from all depths of the measured water column. Ten to fifteen drops of a 2% magnesium carbonate suspension were immediately added to each sample to minimize degradation of the chlorophyll a pigment. Following delivery to the Ministry of the Environment's laboratory facilities in Kingston, the samples were filtered using 1.2 micron filter papers, wrapped in aluminium foil to prevent light from reaching the residue, refrigerated and finally analysed by staff of the Ministry's Laboratory Services Branch.

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake: Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake: Secchi disc readings tend to be less than 3m (9 feet).

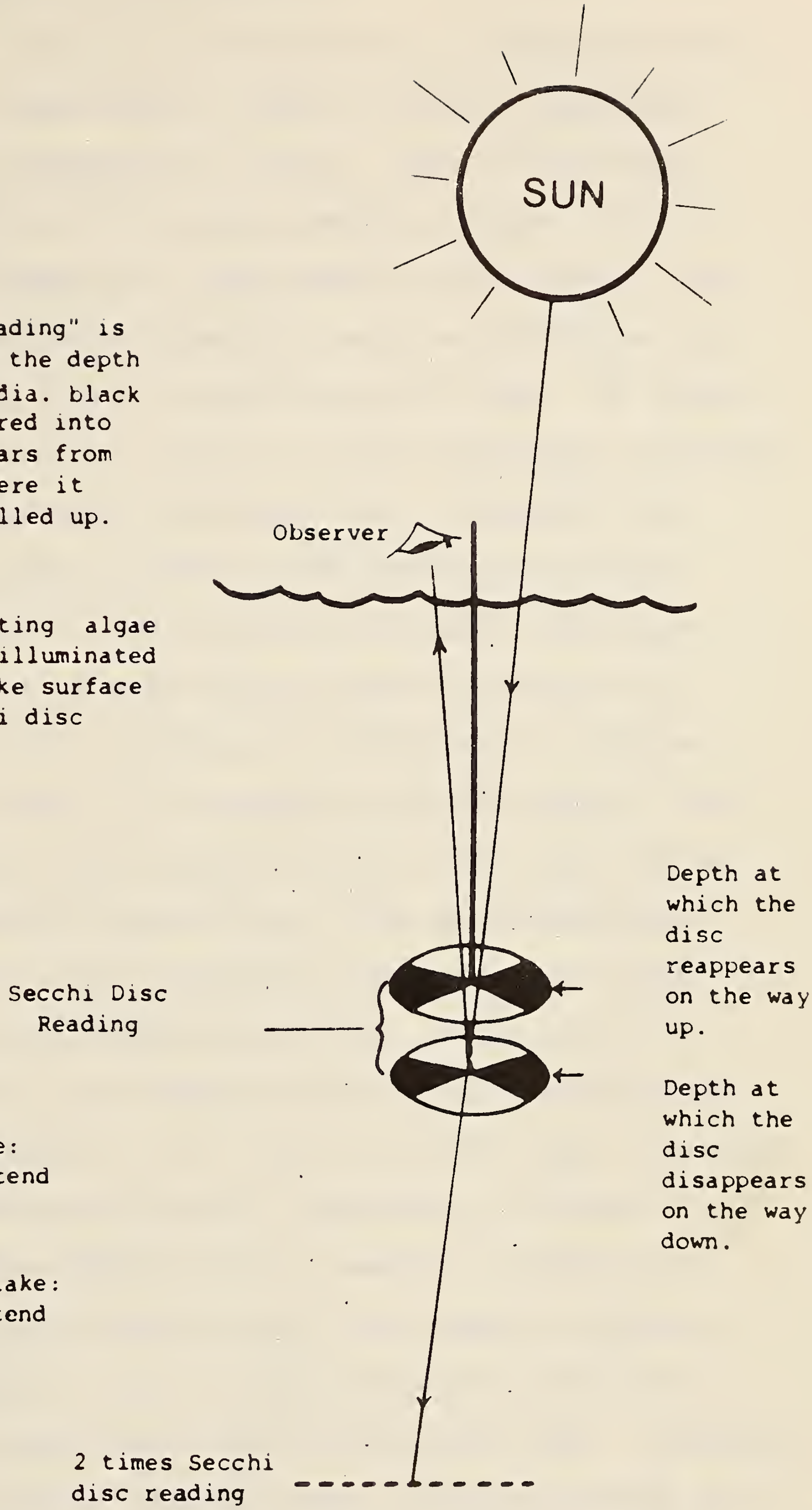


FIGURE 1: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY

DISCUSSION OF RESULTS

Mean Secchi disc values and chlorophyll a concentrations for the 19 lakes are summarized in Table 2 and the individual measurements are presented in Table 4. Some of the lakes are represented by more than one sampling station. This is particularly desirable for a lake which is divided into one or more basins, or has a number of large bays which may act independently from a water quality point of view. It should be realized that, in many cases, the data represent conditions in July, August and early September only; therefore the absence of heavy algal growths in the spring and/or fall cannot be confirmed. Some discretion should be exercised when comparing some of these lakes since the timing and numbers of Secchi disc readings and chlorophyll a samples vary from lake to lake. For example, only four sets of data were obtained from Crowe Lake and Salmon Trout Lake, while 19 sets were acquired from the east basin of Loughborough Lake; consequently a more realistic appraisal can be made for the east basin of Loughborough Lake. Only one set of data was collected from O'Mearas Bay in Big Rideau Lake and two sets from stations A, B, C, and D in Devil Lake, therefore these sites are omitted from the comparisons in Figure 2 and Table 3. Two of the sampling sites, Bane Bay of White Lake and Station C in Otty Lake were not deep enough to obtain a Secchi disc reading. This is also occasionally true for a couple of shallow sampling sites in Big Rideau Lake. Composite water samples for these locations were collected through the column of water extending from the surface to approximately 0.5 meter above bottom.

Table 2: Summary of the mean values for Secchi disc (meters) and chlorophyll a (micrograms per liter) data collected from nineteen lakes in the Southeastern Region during the summer of 1975.

LAKE	SECCHI DISC (meters)	CHLOROPHYLL a (µg/1)
1. Baptiste -1	3.4)	2.2)
-2	3.0)*	2.0)*
2. Big Rideau - central	4.6)	1.4)
- Briton Bay	4.8)*	1.6)*
- Houghton Bay	4.0)	1.4)
- Little Lake	4.0	3.4
- O'Mearas Bay	3.7	2.4
3. Bobs - Long Bay	5.3)	2.4)
- Eastern Basin	5.4)*	2.4)*
4. Collins Bay	2.8	4.2
5. Lac Coulonge	3.2	1.7
6. Crowe	4.7	2.7
7. Devil - 1	7.7)	1.8)
- 2	7.6)*	2.6)*
- A	5.4	1.6
- B	5.4	1.8
- C	5.0	1.8
- D	4.8	2.4
8. Glanmire	3.6	6.3
9. Grippen	2.9	2.6
10. Hurds	4.8	1.7
11. Limerick	5.0	1.1
12. Loughborough - East	2.3	4.9
- West	4.1	2.1
13. Mazinaw - Upper	5.7)	1.1)
- Lower	5.6)*	1.0)*
14. Mink	3.8	1.8
15. Otter	3.2	1.4

LAKE		SECCHI DISC (meters)	CHLOROPHYLL a (μg/1)
16. Otty	-A	4.5)	1.8)
	-B	4.5)*	1.8)*
	-C	-	1.4
17. Salmon Trout		3.0	7.9
18. White (Frontenac County)		4.9	1.3
19. White	- 1	3.1)	3.6)
	- 2	3.1)*	4.1)*
	- 7	3.0)	4.1)
	- Bane Bay	-	1.9

* Due to similarity between stations, values were averaged for inclusion in the graph at Figure 2.

Mean Secchi disc depths are lowest in the east basin of Loughborough Lake (2.3 meters*) and Collins Bay (2.8 meters). The most transparent lakes are Devil (7.6 meters) and Mazinaw (5.6 meters). Lakes with Secchi disc readings exceeding 5 meters have little biological enrichment and are termed oligotrophic. Oligotrophic lakes have a low nutrient supply in relation to their volume and are almost invariably large deep basins. Secchi depths between three meters and five meters typify most of our lakes and are indicative of a moderate amount of enrichment. These lakes are termed mesotrophic and are generally mid-size basins with maximum depths under fifty feet. Lakes with Secchi readings less than three meters are eutrophic and are exhibiting an attenuation of light transmission due in part to high concentration of algae suspended in their waters.

In general chlorophyll a concentrations are low; the highest values were found in Salmon Trout Lake (7.9 micrograms per litre) and Glanmire Lake (6.3 micrograms per litre). High chlorophyll levels were also periodically observed in Little Lake, Collins Bay, the east basin of Loughborough Lake and White Lake (Renfrew and Lanark Counties). Concentrations between 0 and 2 micrograms per litre indicate low levels of algae. Concentrations between 2 and 5 micrograms per litre, although moderately high, may be considered acceptable for

* multiply meters by 3.28 to obtain feet

most water-oriented recreational pursuits. Levels exceeding 5 micrograms per litre on a seasonal average reflect high algal densities. At these higher levels deterioration of water quality for activities such as swimming and water-skiing may be expected, as well as a reduction in aesthetic quality.

As pointed out earlier, Secchi disc readings indicate the depths at which light penetrates into a lake and a chlorophyll a is a photosynthetic green pigment in algae. Since light penetration is effected by the amount of algae suspended in the water, a good co-relation has been found to exist between Secchi disc readings and the amount of chlorophyll a in a series of lakes of varying degrees of enrichment. The curve in Figure 2 depicts this relationship of a large number of data sets collected for many lakes in the province. This curve differs somewhat from the one presented in previous reports in that it has been modified to compensate for the interference of light transmission attributable to dissolved coloured matter.

Oligotrophic lakes, which allow significant light penetration and have low chlorophyll a levels, lie along the vertical arm of the curve in the upper left of the graph; while points for eutrophic or highly enriched lakes, characterized by poor water quality and high chlorophyll a concentrations, are situated along the horizontal arm in the lower right

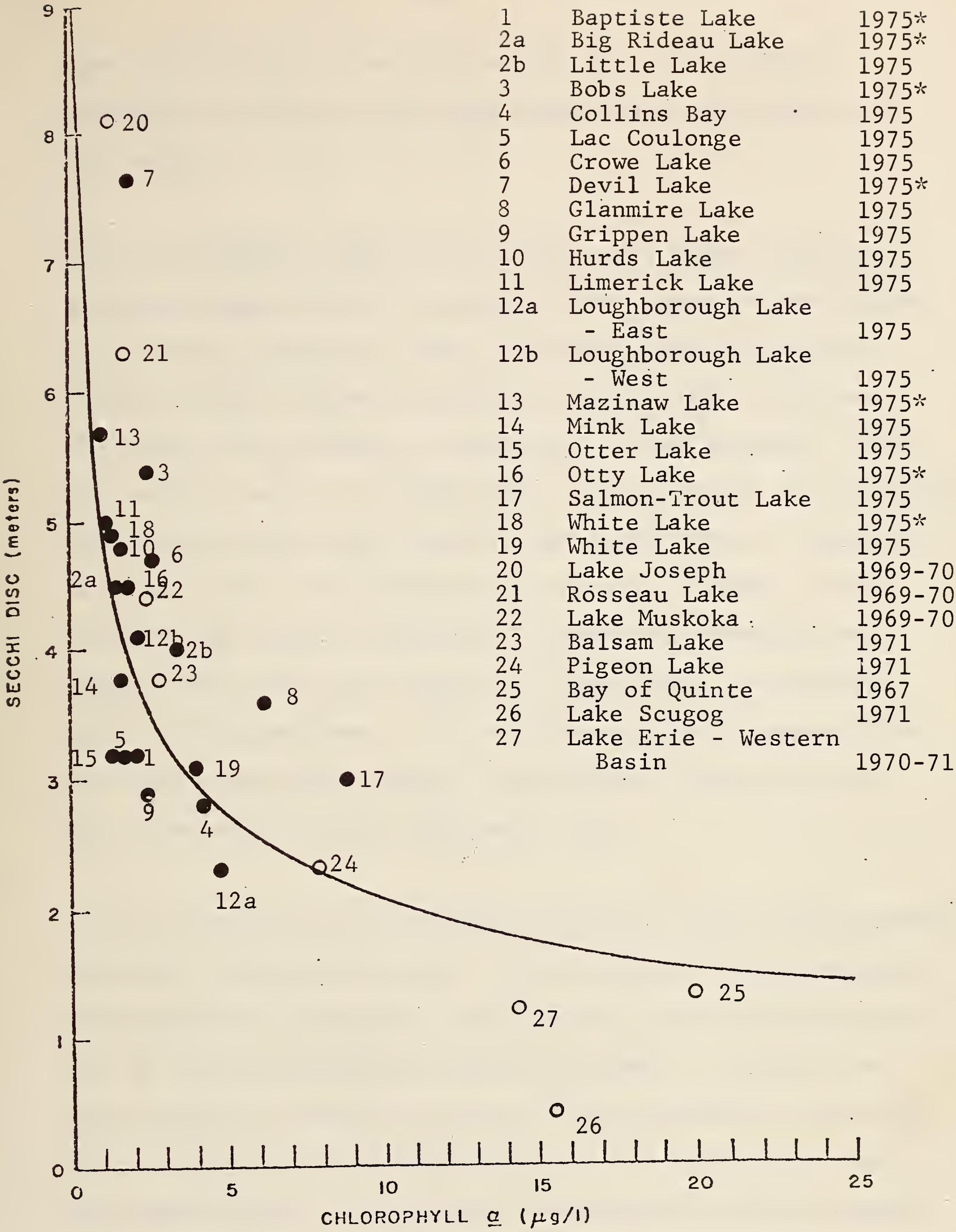


Figure 2: The relationship between Secchi disc and chlorophyll a for nineteen lakes in the Southeastern Region of Ontario. Values for all lakes are based on means of values collected during the summer of 1975. Also, information from a number of other lakes is included as an indication of the relative status of the lakes.

* Due to similarity between stations within the lakes, values were averaged for inclusion in the above graph.

area of the graph. Data for mesotrophic or moderately productive lakes are dispersed about the middle section of the curve.

Devil and Mazinaw Lakes are situated near Lakes Joseph and Rousseau respectively, two oligotrophic lakes in the Muskoka Lakes area of Ontario. Bobs, Limerick, White (Frontenac County), Hurds, Crowe, Big Rideau and Otty Lakes are near the border line between oligotrophic and mesotrophic. Mink, the western basin of Loughborough, Little, Otter, Lac Coulonge, and Baptiste Lakes are located near Balsam Lake, a moderately enriched lake of the Kawartha Lakes area. Grippen, White (Renfrew and Lanark Counties), Collins Bay, Glanmire and Salmon Trout Lakes are closer to Pigeon Lake, an enriched lake in the Kawarthas. All the lakes are well removed from the highly eutrophic waters in the western basin of Lake Erie, the Bay of Quinte and Lake Scugog.

Devil, Salmon Trout and Glanmire Lakes are positioned somewhat above the established curve. In all three of these lakes an elevated mean chlorophyll concentration can be attributed to one or two high readings during the summer. Station 2 on Devil Lake was observed to have 6.5 micrograms per litre on July 2, but since the Secchi disc was 7.3 meters this may have resulted due to accidental contamination of the sample or analytical error. Salmon Trout Lake was observed to have

developed an algal "bloom" in early July during which the chlorophyll a concentration reached 21 micrograms per litre with a corresponding reduction in water clarity to 1.1 meters. A bloom is an unusually large number of algal cells per unit volume of water which can be discerned visually by a green or brown discolouration and a reduction in water clarity. Chlorophyll and Secchi disc readings returned to normal for the remainder of the sampling period in Salmon Trout Lake. High concentrations of 15 micrograms per litre were recorded for Glanmire Lake in August and 6.7 micrograms per litre in late September.

Two sampling stations, Station C in Otty Lake and Bane Bay in White Lake, have lower chlorophyll a levels than the open water areas of their respective lakes. Both of these sites are two shallow to have permitted Secchi disc readings and therefore could not be positioned on the graph. Since water samples could not be collected through the same eutrophic zone as in the mid-lake stations, no direct comparison can be made. However, it may be speculated that competition for nutrients by rooted aquatic plants in proximity to these shallow sites suppressed the production of algae in the water column.

Some lakes have now been sampled for a number of consecutive years (see Table 3). In most cases annual variations in Secchi disc readings and/or chlorophyll a concentrations are minor and can be attributed to year to year variations in sunlight, rainfall, flushing and nutrient levels within the watershed of each lake. The past summer appears to have favoured algal production as chlorophyll a concentrations in all the lakes are higher than that reported for 1974. The 1975 results, however, are similar to those observed in earlier years in lakes for which comparative data is available.

RECOMMENDATIONS

Due to the annual variation of Secchi disc depths and chlorophyll a concentrations, sampling is required for a number of years in order to define long term trends. It is hoped that participants will consider a continuation of their program so that the Ministry of Environment will have a record of water quality on their lake and be alerted to any deterioration should it occur so that possible remedial action can be taken. In particular, further monitoring of Salmon Trout and Glanmire Lakes, preferrably over longer sampling seasons is required to better define their enrichment status. In fact Glanmire Lake has been included in the 1976 Ministry of the Environment/Ministry of Natural Resources water quality survey.

Table 3: Summary of mean values for Secchi disc (meters) and chlorophyll a (micrograms per litre) data for lakes in the Southeastern Region which have two or more years of data available.

LAKE	1975 S.D.	1975 Chl. a	1974 S.D.	1974 Chl. a	1973 S.D.	1973 Chl. a	1972 S.D.	1972 Chl. a	1971 S.D.	1971 Chl. a
Baptiste - 1	3.4	2.2)	3.4	0.4						
- 2	3.0	2.0)								
Crowe	4.7	2.7	4.7	1.2			3.8	1.7		
Devil - 1	7.7	1.8)	5.7	1.5						
- 2	7.6	2.6)								
Loughborough										
- East	2.3	4.9	2.7	2.6	3.3	3.3)	3.1	2.6		
- West	4.1	2.1	3.8	2.0	4.0	1.2)				
Mink	3.8	1.8			3.2	1.2				
Otty - A	4.5	1.8	3.6	1.0	4.0	1.9)			3.2	2.2
- B	4.5	1.8	4.0	1.1	4.2	1.9)				
Salmon Trout	3.0	7.9	3.7	1.4						
White - 1	3.1	3.6	3.2	1.8	2.7	3.4)	1.8	4.8		
- 2	3.1	4.1	2.8	2.6	2.5	5.3)				
- 7	3.0	4.1								
- Bane Bay		1.9								

Table 4: Secchi disc (meters) and chlorophyll a (micrograms per liter) data collected from nineteen lakes in the Southeastern Region during the summer of 1975. Mean values are also presented.

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (μg/1)
Baptiste -1	July 7	3.3	-
	13	2.5	2.4
	20	3.0	1.5
	Aug. 6	3.4	2.7
	13	4.2	2.3
	20	3.8	1.9
Mean		3.4	2.2
-2	July 7	3.0	-
	13	2.2	1.2
	20	2.7	1.7
	Aug. 6	3.5	2.9
	13	2.9	2.1
	20	3.8	1.9
Mean		3.0	2.0
Big Rideau Little Lake	June 22	3.4	9.3
	July 4	4.3	8.6
	6	4.3	2.0
	13	3.7	2.2
	20	4.0	1.4
	29	4.0	1.0
	Aug. 10	4.3	1.5
	18	3.7	1.6
Mean		4.0	3.4
Briton Bay	July 28	4.6	1.7
	Aug. 3	5.8	2.6
	10	4.9	1.8
	17	5.0	0.7
	Sept. 7	4.7	-
	28	4.1	1.1
Mean		4.8	1.6

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (μg/1)
Big Rideau (Cont'd)			
Houghton Bay	Aug. 4	4.3	1.4
	10	3.8	1.9
	17	4.0*	1.3
	Sept. 14	3.0*	1.1
Mean		4.0	1.4
O'Mearas Bay	May 8	3.7	2.4
Portland	May 19	3.7	1.1
	July 13	3.4*	2.0
Trout Island	May 19	4.0	1.4
	Aug. 10	4.3	1.4
Tar Island	Aug. 4	5.2	1.7
	10	4.4	1.2
	17	4.6	1.2
	Sept. 14	3.7	1.3
Rocky Narrows	July 30	5.6	1.5
	Aug. 3	5.8	2.4
	19	5.2	1.4
	24	4.6	1.6
	Sept. 1	4.9	0.6
	7	4.3	1.3
	21	4.3	1.4
Mean		4.6	1.4
Bobs			
Long Bay	July 28	5.5	-
	Aug. 3	4.9	2.4
	10	6.2	-
	17	5.8	3.7
	24	5.2	1.6
	Sept. 1	4.6	2.0
	--	4.9	-
Mean		5.3	2.4
Eastern Basin	July 28	6.0	3.2
	Aug. 3	6.4	2.0
	10	5.8	2.4
	17	6.1	2.3
	24	4.9	2.3
	Sept. 1	4.0	2.1
	--	4.3	2.5
Mean		5.4	2.4

* Secchi disc on bottom.

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (μg/1)
Collins Bay	June 1	2.9	4.9
	8	2.3	5.1
	15	2.3	6.9
	23	2.3	6.2
	29	3.2	2.5
	July 6	1.7	2.7
	13	2.0	6.5
	20	1.7	1.4
	Aug. 20	2.7	4.2
	Sept. 7	3.2	4.2
	14	3.2	0.6
	21	2.9	4.7
	29	3.8	5.0
	Oct. 7	3.8	4.0
	Nov. 7	4.1	3.5
Mean		2.8	4.2
Lac Coulonge	July 6	2.7	1.5
	13	3.2	1.1
	20	2.9	1.2
	27	2.6	2.0
	Aug. 4	3.2	2.3
	10	4.1	1.5
	17	3.4	2.1
Mean		3.2	1.7
Crowe	Aug. 24	4.9	2.9
	31	4.6	2.3
	31	4.6	1.9
	Sept. 7	4.6	3.8
Mean		4.7	2.7
Devil - 1	July 2	7.5	1.5
	16	7.6	0.9
	23	8.2	1.9
	Aug. 5	7.3	2.2
	18	7.5	2.9
	28	8.2	1.4
Mean		7.7	1.8
- 2	July 2	7.3	6.5
	16	7.5	1.3
	23	7.2	1.1
	Aug. 18	8.1	2.4
	28	8.1	1.5
Mean		7.6	2.6
- A	Oct. 7	5.8	1.9
	25	5.1	1.2
Mean		5.4	1.6

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (µg/1)
Devil - B	Oct. 7	5.6	1.7
	25	5.2	1.8
Mean		5.4	1.8
- C	Oct. 7	5.2	1.5
	25	4.8	2.0
Mean		5.0	1.8
- D	Oct. 7	5.1	1.9
	25	4.5	2.8
Mean		4.8	2.4
Glanmire	July 6	4.1	-
	13	4.1	1.8
	Aug. 4	4.3	-
	10	4.0	15.0
	Sept. 7	3.5	1.6
	14	3.4	-
	28	1.8	6.7
Mean		3.6	6.3
Grippen	May 19	2.1	5.6
	25	2.7	3.5
	June 1	2.1	4.8
	15	2.1	2.0
	22	1.8	-
	July 1	1.8	1.0
	14	2.5	1.7
	23	3.4	1.4
	30	3.4	1.6
	Aug. 6	3.5	2.5
	10	4.3	1.8
	24	4.6	2.8
Mean		2.9	2.6
Hurds	July 1	4.1	1.3
	8	4.1	1.1
	20	4.6	2.5
	28	4.1	1.7
	Aug. 4	4.9	3.6
	10	5.3	0.8
	17	5.8	1.7
	24	5.5	0.2
	31	5.2	2.0
	Sept. 7	4.7	1.7
Mean		4.8	1.7

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (μg/l)
Limerick	Aug. 1	5.3	1.1
	5	5.5	1.1
	10	5.2	1.6
	12	4.9	-
	20	5.2	0.6
	24	4.3	0.8
	Sept. 3	4.7	1.1
	9	5.2	0.7
	Oct. 8	5.0	1.6
	14	4.9	1.4
Mean		5.0	1.1
Loughborough - East	June 9	2.7	9.3
	18	2.7	6.3
	25	3.8	4.0
	July 2	3.0	2.8
	10	3.2	3.8
	18	2.4	4.0
	28	2.1	7.3
	Aug. 5	2.3	2.2
	12	2.1	4.8
	19	1.7	6.3
	26	1.6	4.6
	Sept. 2	1.5	6.7
	11	1.5	4.0
	22	1.8	5.9
	28	2.3	4.6
	Oct. 6	2.1	3.5
	14	2.6	4.4
	24	2.6	2.9
	Nov. 5	2.4	5.9
Mean		2.3	4.9
- West	June 30	4.0	0.9
	July 6	5.3	2.4
	13	4.6	0.9
	20	4.0	1.8
	Aug. 4	2.7	4.2
	10	2.7	2.0
	17	2.7	1.7
	25	4.3	2.8
	Sept. 7	6.4	2.2
Mean		4.1	2.1
Mazinaw - Upper	Aug. 11	5.8	1.0
	25	5.5	1.1
	Sept. 1	5.2	1.3
	7	5.8	0.7
	14	5.8	1.7
	Oct. 12	6.1	1.2
	29	-	0.5
Mean		5.7	1.1

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (μg/l)
Mazinaw (cont'd)			
- Lower	June 22	5.0	-
	29	5.8	0.9
	July 6	5.5	0.9
	14	5.2	0.5
	21	5.8	1.7
	28	5.2	0.8
	Aug. 4	5.8	0.9
	11	5.8	1.0
	25	5.5	0.9
	Sept. 1	5.0	0.9
	7	5.8	0.6
	14	6.4	1.6
	Oct. 12	6.1	1.2
	29	-	0.8
Mean		5.6	1.0
Mink	June 4	4.9	0.4
	4	4.9	1.1
	10	4.4	1.3
	17	3.4	3.7
	25	3.4	3.7
	July 1	4.1	2.7
	8	3.0	0.5
	17	3.5	1.0
	26	3.8	1.0
	Aug. 9	3.8	1.0
	25	3.6	1.3
	Sept. 3	3.7	1.2
	10	3.1	5.9
	15	3.0	2.3
	Oct. 5	3.7	1.4
	26	3.0	1.1
	Nov. 3	4.1	2.0
	9	4.4	1.4
Mean		3.8	1.8
Otter	July 21	2.9	0.8
	31	3.7	1.5
	Aug. 7	3.0	2.1
	12	3.2	1.3
	18	2.7	1.0
	28	3.0	1.2
	Sept. 4	3.0	1.2
	28	3.7	2.1
	Oct. 8	4.0	1.8
Mean		3.2	1.4

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLLA a (μg/1)
Otty - A	May 21	4.6	2.4
	June 3	5.0	3.0
	10	5.2	3.9
	17	4.6	2.0
	24	4.5	1.2
	July 1	4.8	1.5
	8	4.1	0.6
	16	4.0	1.0
	22	4.3	1.3
	29	4.0	0.9
	Aug. 5	4.3	2.2
	12	3.8	1.8
	19	4.0	2.1
	28	4.6	1.3
	Sept. 7	5.0	1.3
	14	4.9	2.1
Mean		4.5	1.8
- B	May 21	4.5	2.7
	June 3	5.2	1.7
	10	5.1	2.4
	17	4.3	2.1
	24	4.5	1.2
	July 1	4.8	2.2
	8	3.9	1.4
	16	4.0	0.9
	22	4.3	1.1
	29	4.1	1.6
	Aug. 5	4.1	2.2
	12	3.9	1.7
	19	3.8	2.4
	28	4.3	1.4
	Sept. 7	5.3	0.9
	14	5.2	3.6
Mean		4.5	1.8
- C	May 21		3.4
	June 3		0.9
	10		1.1
	17		1.6
	24		0.8
	July 1		1.6
	8		0.9
	16		1.6
	22		0.8
	29		1.1
	Aug. 5		1.5
	12		1.1
	19		1.7
	28		1.3
	Sept. 7		1.3
	14		1.7
Mean			1.4

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (µg/1)
Salmon Trout	July 1	1.1	21.0
	13	3.5	2.1
	Aug. 6	4.0	3.3
	24	3.4	5.1
Mean		3.0	7.9
White (Frontenac Co.)	May 25	4.0	2.0
	June 8	4.9	1.8
	22	5.6	1.2
	July 1	5.6	-
	6	5.0	1.6
	27	4.3	1.5
	Aug. 4	5.2	1.1
	10	4.9	0.9
	17	4.6	0.7
	Sept. 7	4.9	1.3
Mean		4.9	1.3
White (Renfrew & Lanark Co.) - 1	June 8	3.4	2.3
	15	3.4	3.0
	22	3.2	3.4
	July 6	3.3	2.7
	13	2.8	3.1
	Aug. 4	4.7	-
	10	2.4	3.2
	25	2.3	4.9
	Sept. 1	2.4	5.3
	7	3.0	4.9
Mean		3.1	3.6
- 2	June 8	3.9	3.5
	15	3.0	5.4
	22	3.4	2.9
	July 6	3.7	3.6
	13	2.9	3.0
	Aug. 4	3.4	3.9
	10	2.7	3.2
	25	2.3	6.5
	Sept. 1	2.3	4.7
	7	3.0	4.7
Mean		3.1	4.1

LAKE	DATE	SECCHI DISC (m)	CHLOROPHYLL a (μg/1)
White (cont'd)			
- 7	June 8	3.2	2.7
	15	3.0	10.3
	22	3.4	2.5
	July 13	2.4	3.2
	Aug. 4	3.2	-
	10	2.3	2.5
	25	3.0	4.5
	Sept. 1	3.0	-
	7	3.4	2.7
Mean		3.0	4.1
- Bane Bay	June 15		2.7
	22		0.8
	July 6		1.6
	13		1.5
	Aug. 4		-
	10		1.6
	25		2.2
	Sept. 1		2.4
	7		2.1
Mean			1.9

APPENDIX A

INFORMATION OF GENERAL INTEREST TO COTTAGERS

MICROBIOLOGY OF WATER

For the sake of simplicity, the micro-organisms in water can be divided into two groups; the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less serious infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satifactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will give rise in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attacked by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

RAINFALL AND BACTERIA

The "Rainfall Effect" relates to a phenomenon that has been documented in previous surveys of recreational lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO RIVER OR LAKE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling
Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination using a household bleach containing 4 to 5 1/4% available chlorine.
Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometimes coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH

Per 10 ft. Depth of Water

Diameter of Well Casing in Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz.	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful in removing particles, if water is periodically turbid, and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario provincial law requires under Part 7 of the Environmental Protection Act that before you extend, alter, enlarge or establish any building where a sewage system will be used, a Certificate of Approval must be obtained from the Ministry of the Environment or its representatives. The local municipality or Health Unit may be delegated the authority to issue the Certificate of Approval. Any other pertinent information such as size, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream, pond, spring, river or reservoir
- 5 feet to any building
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well
- 50 feet to a drilled well which has a casing to 25 feet below ground
- 25 feet to a building with a basement that has a floor below the level of the tile in the tile bed
- 10 feet to any other building
- 10 feet to a property boundary
- 50 feet to any lake, stream, pond, spring, river or reservoir.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct connection to the lake. Thus, if a cottager dye-tested his

system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING & MARINA REGULATIONS

In order to help protect the lakes and rivers of Ontario from pollution, it is required by law that sewage (including garbage) from all pleasure craft, including houseboats, must be retained in suitable equipment. Equipment which is considered suitable by the Ministry of the Environment includes (1) retention devices with or without re-circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

Equipment for storage of toilet wastes shall:

1. be non-portable
2. be constructed of structurally sound material
3. have adequate capacity for expected use
4. be properly installed, and
5. be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1½-inch diameter National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. If the bilge is cleaned, the waste material must not be dumped into the water.
4. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
5. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back"
6. Empty oil cans must be deposited in a leak-proof receptacle, and
7. Slow down and save fuel.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing a regulation to prevent pollution from ice-oriented recreational activities.

Garbage or sewage left on the ice pollutes the lakes or rivers. The bottoms of ice shelters (ice-fishing huts) or other debris, if left on the ice, may become a hazard later on to boaters and water skiers or a litter problem on some cottager's beach. While bathing, summer vacationists have been badly cut by broken glass and other sharp objects reportedly left on the ice by winter anglers.

With the anticipated enforcement of the regulations, all of these offences will be subject to stricter control.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

In recent years, cottagers have become aware of the problems associated with nutrient enrichment of recreational lakes and have learned to recognize many of the symptoms characterizing nutrient enriched (eutrophic) lakes. It is important to realize that small to moderate amounts of aquatic plants and algae are necessary to maintain a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool, which is essential to certain species of fish and also provides protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years during which extra nutrients are added to the lake and return to the natural state may also take a number of years after the nutrient inputs are stopped.

Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water received no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

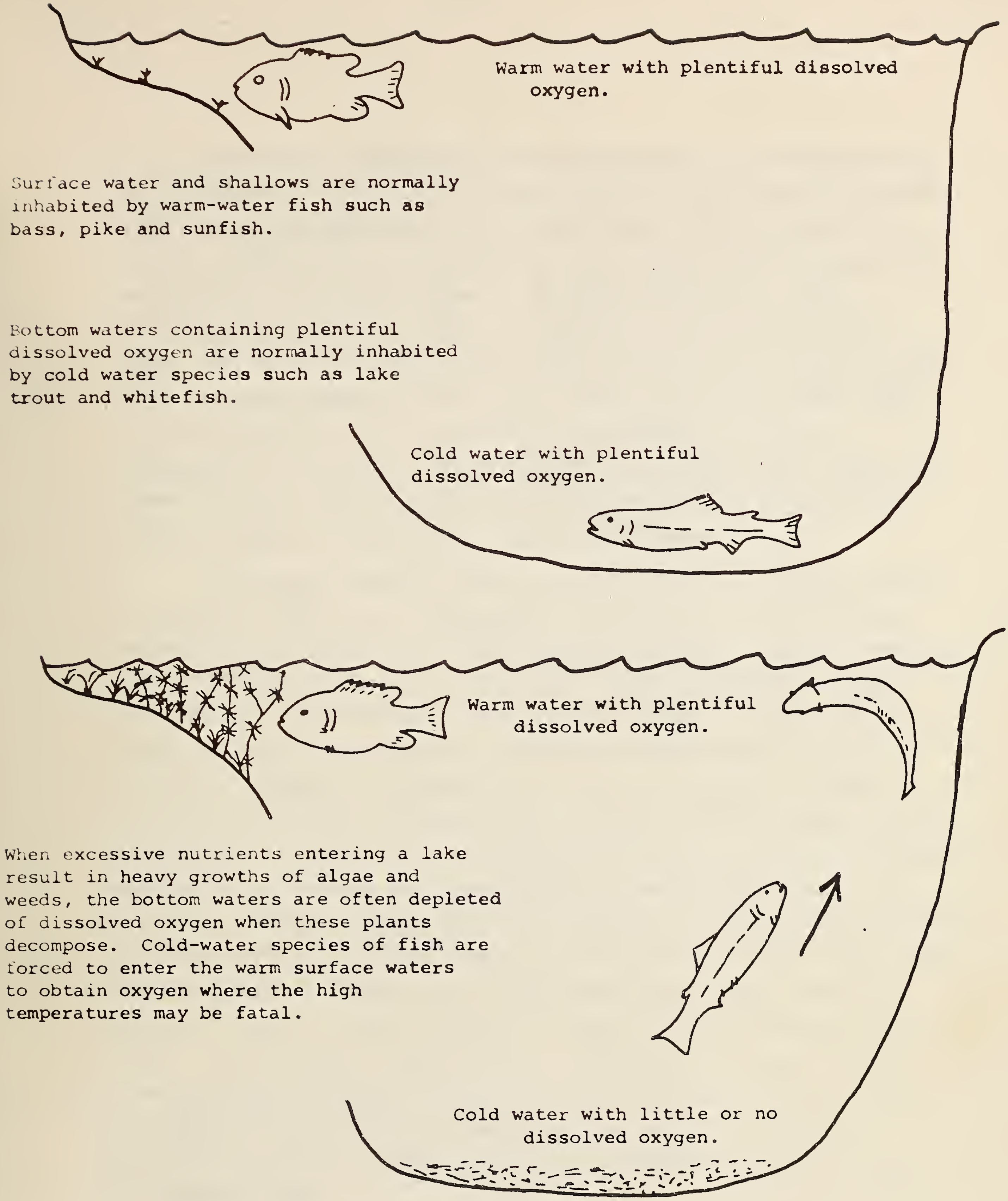


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition in the bottom waters can aggravate the condition and in some cases result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and more vulnerable to nutrient inputs than lakes which retain some oxygen.

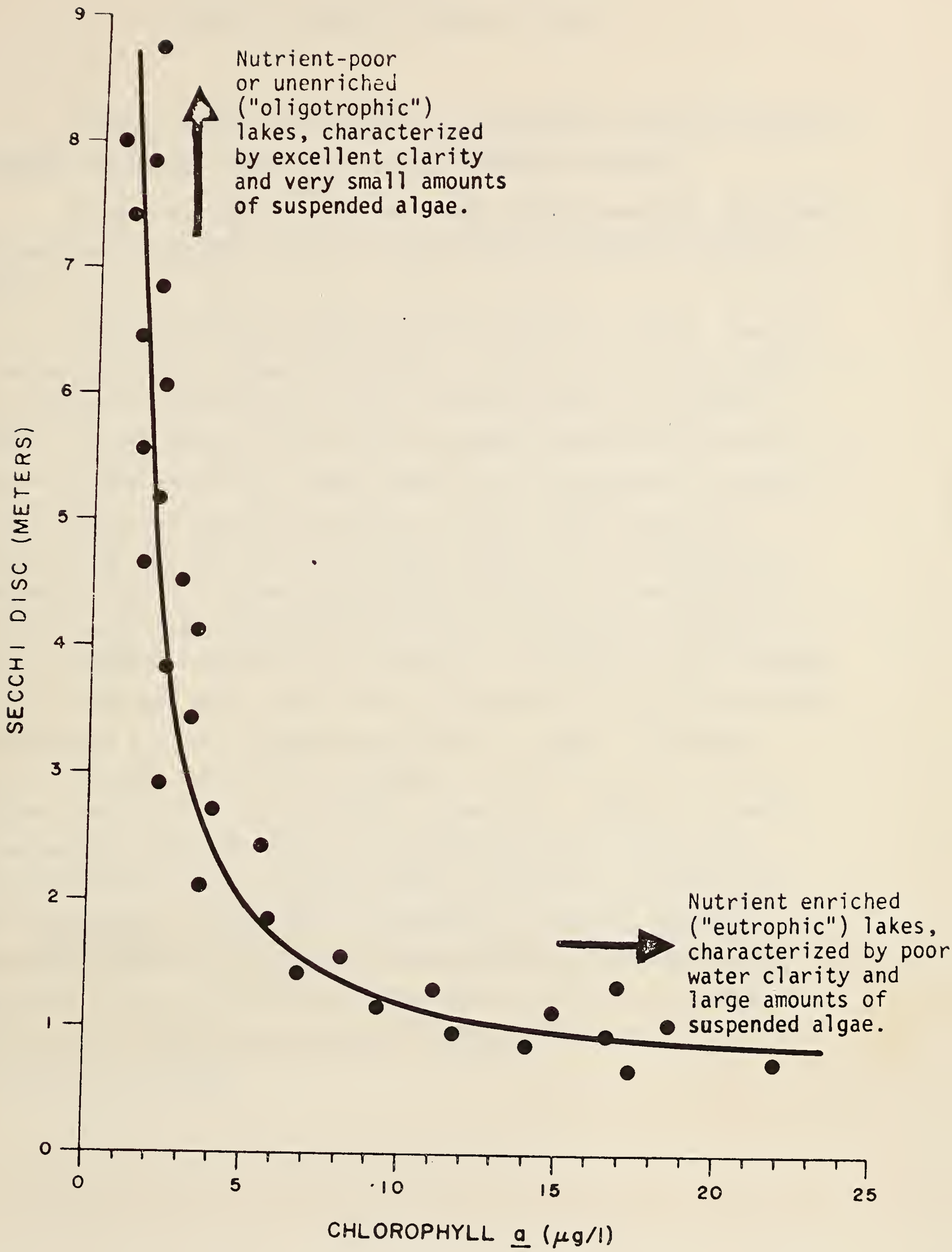
Like humans, aquatic plants and algae require a balanced "diet" for growth. Other special requirements including those for light and temperature are specific for certain algae and plants. Chemical elements such as nitrogen, phosphorus, carbon, and several others are required and must be in forms which are available for uptake by plants and algae. Growth of algae can be limited by scarcity of any single "critical" nutrient. Nitrogen and phosphorus are usually considered "critical" nutrients because they are most often in scarce supply in natural waters, particularly in lakes in the Precambrian area of the province. Phosphorus, especially is necessary for the processes of photosynthesis and cell division. Nitrogen and phosphorus are generally required in the nitrate-N (or ammonia-N) and phosphate forms and are present in natural land runoff and precipitation. Human and livestock wastes are a very significant source of these and other nutrients for lakes in urban and agricultural areas. It is extremely important that cottage waste disposal systems function so that seepage of nutrients to the lake does not occur since the changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

The large amounts of suspended algae which materialize from excessive inputs of nutrients, result in turbid water of poor clarity or transparency. On the other hand, lakes with only small, natural inputs of nutrients and correspondingly low nutrient concentrations

(characteristically large and deep lakes) most often support very small amounts of suspended algae and consequently are clear-water lakes. An indication of the degree of enrichment of lakes can therefore be gained by measuring the density of suspended algae (as indicated by the chlorophyll a concentration - the green pigment in most plants and algae) and water clarity (measured with a Secchi disc). In this regard staff of the Ministry of the Environment have been collecting chlorophyll a and water clarity data from several lakes in Ontario and have developed a graphical relationship between these parameters which is being used by cottagers to further their understanding of the processes and consequences of nutrient enrichment of Precambrian lakes. The figure on the following page illustrates the above mentioned relationship.

In the absence of excessive coloured matter (eg. drainage from marshlands), lakes which are very low in nutrients are generally characterized by small amounts of suspended algae (ie. chlorophyll a) and are clear-water lakes with high Secchi disc values. Such lakes, with chlorophyll a and Secchi disc values lying in the upper lefthand area of the graph are unenriched or nutrient-poor ("oligotrophic") in status and do not suffer from the problems associated with excessive inputs of nutrients. In contrast, lakes with high chlorophyll a concentrations and poor clarity are positioned in the lower right-hand area of the graph and are enriched ("eutrophic"). These lakes usually exhibit symptoms of excessive nutrient enrichment including water turbidity owing to large amounts of suspended algae which may float to the surface and accumulate in sheltered areas around docks and bays.

Measurements of suspended algal density (chlorophyll a) and water clarity are especially valuable if carried out over several years. Year to year positional changes on the graph can then be assessed to determine whether or not changes in lake water quality are materializing so that remedial measures can be implemented before conditions become critical.


Nutrient-poor
or unenriched
("oligotrophic")
lakes, characterized
by excellent clarity
and very small amounts
of suspended algae.
Nutrient enriched
("eutrophic") lakes,
characterized by poor
water clarity and
large amounts of
suspended algae.
SECCHI DISC (METERS)
CHLOROPHYLL a (µg/l)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available through local district offices or from Southeastern Region, Ministry of Environment, 133 Dalton Street, Kingston, Ontario K7L 4X6, telephone 549-4000.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAMME

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The programmes response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The programmes makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities became operational at wastewater treatment plants on December 31, 1973, in the most critically affected areas of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition, which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River System, is December 31, 1975. The 1973 phase of the program involved 113 plants, of which 48 are in prime recreational areas. An additional 53 new plants, each with phosphorus removal, are now under development, 23 of which are located in recreational areas. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons.

The 1975 phase will bring into operation another 54 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligram per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained through local district offices or from Southeastern Region, Ministry of Environment, 133 Dalton Street, Kingston, Ontario K7L 4X6, telephone 549-4000.

QH/96.8/E9/C67/1975/MOE
Galloway, D L
Cottagers self -
help program aqha
c.1 a aa